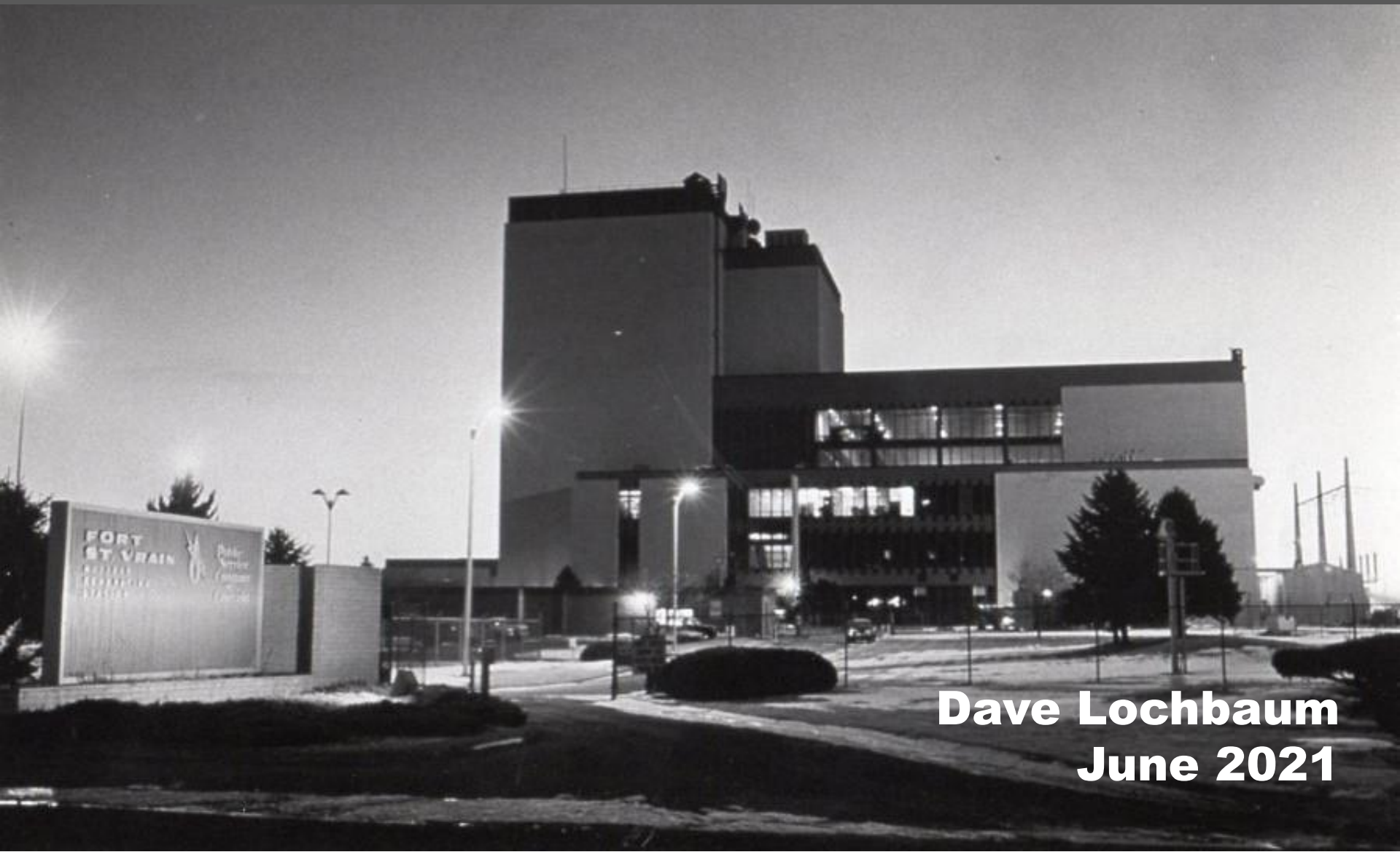
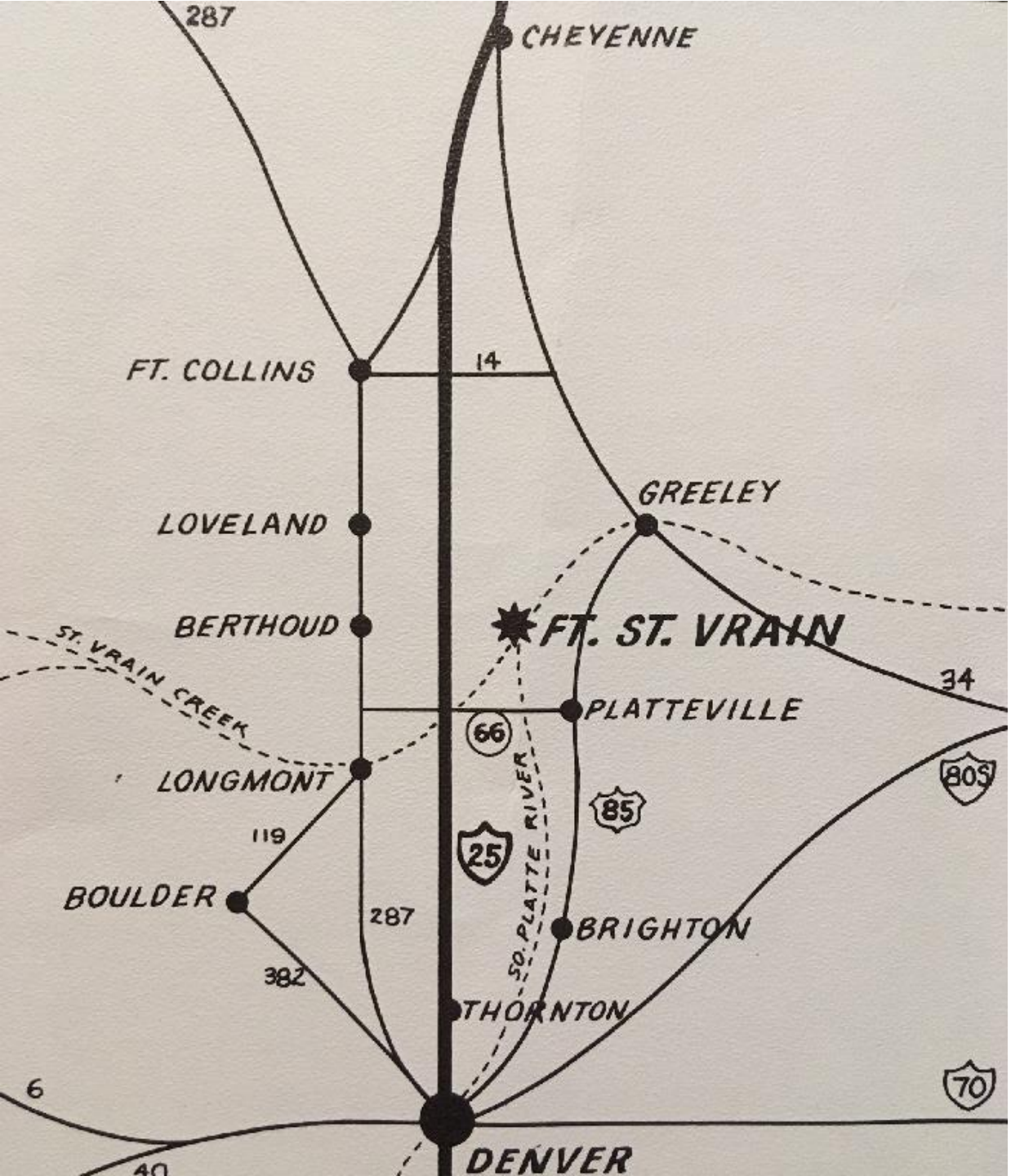
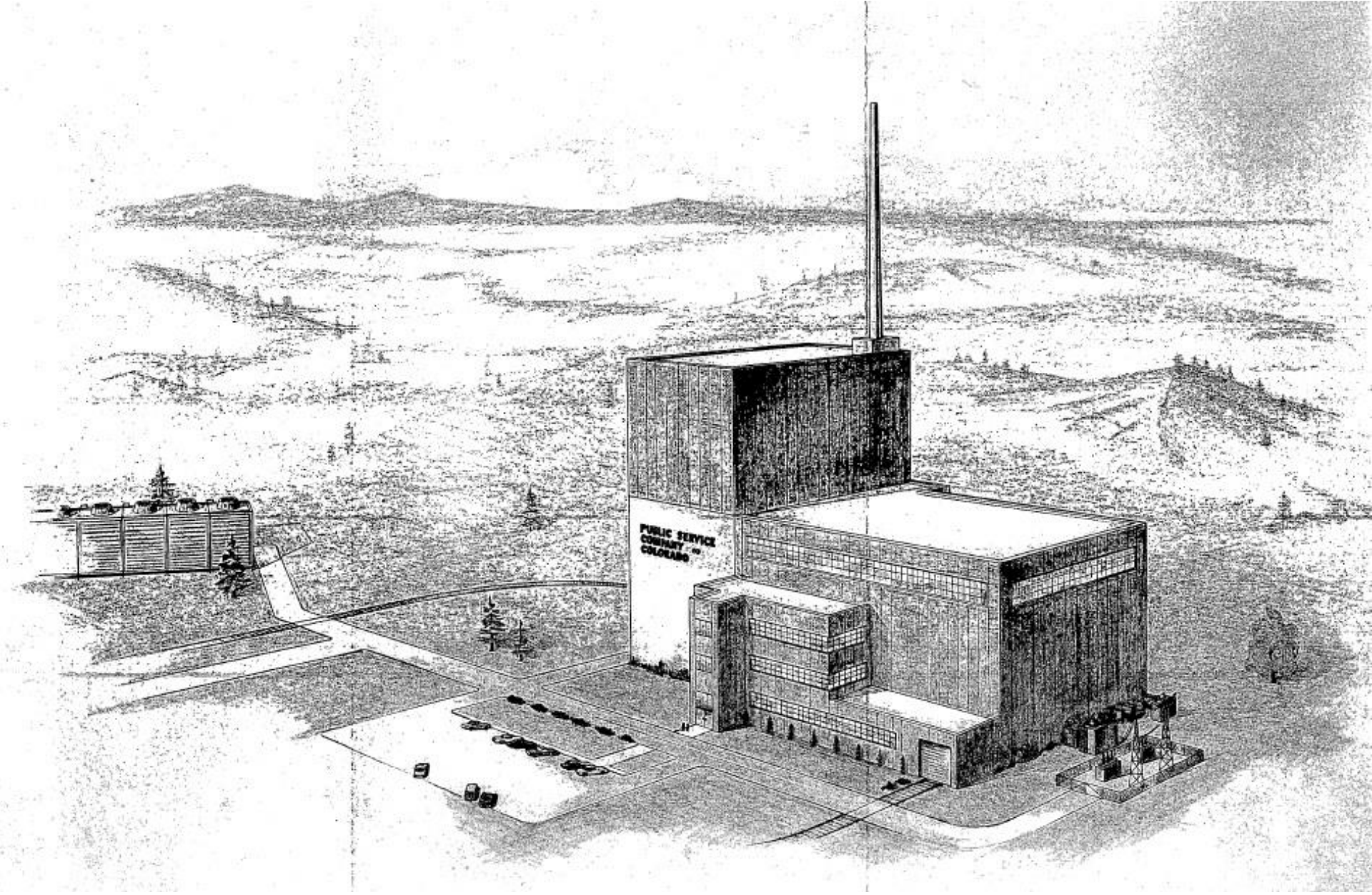
Fort St. Vrain Nuclear Generating Station



Dave Lochbaum
June 2021



Fort St. Vrain is located in Colorado north of Denver and southwest of Greeley.



Fort St. Vrain was a helium-cooled, graphite moderated high temperature gas-cooled reactor using uranium-thorium fuel.

The operators achieved criticality of the reactor core for the first time on January 31, 1974. But problems prevented it from supplying electricity to the power grid until December 11, 1976.

Fort St. Vrain had numerous recurring problems that caused it to operate at a capacity factor of less than 15% over its 15-year life.

On August 18, 1989, control rod problems caused another reactor shut down. The company notified the NRC on August 29, 1989, of its decision not to restart the reactor.

On August 31, 1991, the company submitted its plan for decommissioning the nuclear plant to the NRC.

Explosion Overpressure Damage Estimates

Overpressure* (psig)	Expected Damage
0.03	Occasional breaking of large windows already under stress.
0.04	Loud noise (143 dB); sonic boom glass failures.
0.10	Breakage of small windows under strain.
0.15	Typical pressure for glass failure.
0.30	Some damage to house ceilings; 10% window glass breakage.
0.40	Limited minor structural damage.
0.50 - 1.0	Windows usually shattered; some window frame damage.
0.7	Minor damage to house structures.
1.0	Partial Demolition of houses; made uninhabitable.
1.0 - 2.0	Corrugated metal panels fail and buckle. Housing wood panels blown in.
1.0 - 8.0	Range for slight to serious injuries due to skin lacerations from flying glass and other missiles.
1.3	Steel frame of clad building slightly distorted.
2.0	Partial collapse of walls and roofs of houses.
2.0 - 3.0	Non-reinforced concrete or cinder block walls shattered.
2.3	Lower limit of serious structural damage.
2.4 - 12.2	Range for 1-90% eardrum rupture among exposed populations.
2.5	50% destruction of home brickwork.
3.0	Steel frame building distorted and pulled away from foundation.
3.0 - 4.0	Frameless steel panel building ruined.
4.0	Cladding of light industrial buildings ruptured.
5.0	Wooded utility poles snapped.
5.0 - 7.0	Nearly complete destruction of houses.
7.0	Loaded train wagons overturned.
7.0 - 8.0	8-12 in. thick non-reinforced brick fail by shearing of flexure.
9.0	Loaded train box cars demolished.
10.0	Probable total building destruction.
15.5 - 29.0	Range for 1-99% fatalities among exposed populations due to direct blast effects.

Earlier in 1991, the company notified the NRC about natural gas production wells in the vicinity, one as close as 1,184 feet from the reactor building. Its 16-inch pipeline transported natural gas at 150 psig.

The company also provided the NRC the results of postulated natural gas pipeline rupture scenarios that would result in overpressures of 0.2, 0.3, and 0.6 psig on the reactor building.

Source: ML200298667

On December 2, 1994, the NRC issued a contract for the independent evaluation of natural gas hazards to the decommissioning and onsite storage of spent fuel at Fort St. Vrain. (ML20080D729)

Summary of Analysis of Explosion Hazards at Ft. St. Vrain

	Overpressure (psi)		Impulse (psi-ms)	
Case No	Westinghouse	MAFA	Westinghouse	
1. 12" gas service line 1400 feet away with a Gas cloud 4356 cm radius.	3.3	3.87	252	449
2. 26" rupture at:				
a. 5280 feet away with:				
(1.) A cloud 8316 cm radius.	1.0	1.47	228	447
(2.) A cloud 3.08 cm radius		0.019		0.609
b. 4300 feet away with:				
(1.) A cloud 8316 cm radius.	1.3	1.97	267	548
(2.) A cloud 3.08 cm radius.		0.025		0.763

On May 5, 1995, the independent natural gas hazard evaluation report by Mark A. Frye & Associates (MAFA) was provided to the NRC.

It reported higher overpressure conditions for every postulated event than had been calculated for the company by Westinghouse.

When Fort St. Vrain was initially licensed in December 1973, no natural gas pipelines were located nearby.

A 16-inch natural gas pipeline was installed in 1974 that crossed a corner of the plant's property, about 0.9 miles from the reactor building.

Twelve natural gas wells were drilled between 1981 and 1983, the closest well located 1,524 feet from the reactor building.

In late 1987, a natural gas well was drilled 1,184 feet from the reactor building. Its pipeline passed within 560 feet of the switchyard.

The company permitted these activities via a safety evaluation of a postulated blowout at a gas well. The evaluation did not consider a rupture of a pipeline or the release of a cloud of natural gas that drifted towards the plant before detonating.

In November 1991, the NRC issued a possession-only license amendment for Fort St. Vrain, with a condition that NRC be notified of planned changes to the natural gas pipeline valve operations.

Source: ML031190130

In early 1990, the company decided to repower the site by installing three natural gas fueled combustion turbines and heat recovery steam generators. Natural gas is supplied to the units via a 12-inch diameter pipeline that passes within 1,400 feet of the spent fuel dry storage structure.

In 2009, two additional natural gas fueled combustion turbines were installed at the site.

(Source: ML111110339)

The transfer of spent fuel loaded into 270 canisters to this dry storage structure onsite was completed on June 10, 1992.

The license conditions for the dry storage facility include a mandated natural gas and oil monitoring program.

(Source: ML07284061)

View inside the onsite dry storage structure.

(Source: ML07284061)

On November 23, 1992, the NRC issued an Order approving the company's decommissioning plan. The Order contained a provision preventing any unanalyzed sources of natural gas to be introduced within one-half mile of radioactive materials:

(Source: ML20127F569)

5.11 Natural Gas Restriction

As indicated in Specification 1.0, FSV is being converted to utilize a gas-fired boiler. The natural gas line supplying this boiler, or any other new natural gas source, shall not be introduced within 0.5 miles of the location where ACTIVATED GRAPHITE BLOCKS are stored, for any purpose, without prior NRC approval.

On May 5, 1993, a new source of natural gas was introduced within one-half mile of both the reactor building and the Independent Spent Fuel Storage Installation when a natural gas pipeline was field routed from a new gas well to a collection pipeline.

(Source: ML20045A429)

The Safety Analysis Report (SAR) for the Fort St. Vrain Independent Spent Fuel Storage Installation (ISFSI) explicitly covered the nearby natural gas pipelines. Four scenarios involving natural gas detonations were evaluated:

1) **Rupture of 12-inch pipeline at its closest point to the ISFSI (3.3 psi overpressure)**

2) **Double-ended rupture of the 24-inch supply line 5,280 feet southwest of the ISFSI (1.0 psi overpressure)**

3) **Double-ended rupture of the 24-inch supply line 4,300 feet west of the ISFSI (1.3 psi overpressure)**

4) **Detonation of natural gas inside the turbine building 1,737 feet southwest of the ISFSI (0.7 psi overpressure)**

When proposed changes to natural gas pipeline operations (e.g., increased flow rates, increased internal pressures, excavation near pipelines, etc.) could increase the likelihood or consequences of any events, prior NRC approval would be required.

1

(Source: ML102380351)

The Technical Specifications issued by the NRC for the Fort St. Vrain ISFSI required a Natural Gas and Oil Monitoring Program"

"This program provides a means for monitoring the development of natural gas and oil infrastructure and assessing the risk that such development poses to the FSV ISFSI.

1. The licensee shall establish and maintain a database of all natural gas and oil infrastructure within one-half mile of the FSV ISFSI.

2. The database shall include an analysis of the hazard posed by the failure of individual infrastructure components (such as gas well, collector pipes, transmission pipelines, or feeder pipes). Such analysis bay be a quantitative evaluation of the effect of postulated failures of the MVDS or may be a qualitative comparison to the hazard analysis of bounding cases provided by the safety analyses supporting the initial issuance of and Amendment No. 1 to Materials License SNM-2504."

(Source: ML16258A179)

The Technical Specifications issued by the NRC for the Fort St. Vrain ISFSI required a Natural Gas and Oil Monitoring Program (continued):

3. **"The licensee shall ensure that the database is updated at least once every six months.**

4. **For any new natural gas or oil infrastructure planned or completed installation within one-half mile of the ISFSI, the licensee shall submit a report describing the new infrastructure and a summary of the hazard analysis to the NRC Document Control Desk with a copy to the Director, Office of Nuclear Material Safety and Safeguards and the Regional Administrator, Region IV:**

   a. **Within 60 days of identifying the new infrastructure if that new infrastructure poses a hazard which exceeds that analyzed in the initial issuance of and Amendment No. 1 to Materials License SNM-2504, or**

   b. **With the periodic SAR updated if the new infrastructure poses a hazard bounded by that analyzed I the initial issuance of and Amendment No. 1 to Materials License SNM-2504."**

(Source: ML16258A179)

The Technical Specifications issued by the NRC for the Fort St. Vrain ISFSI required a Natural Gas and Oil Monitoring Program including biennial reports to the NRC. The June 2005 biennial report to the NRC discussed:

1) **A new natural gas well proposed in late 2003 to be installed within a half-mile of the ISFSI.**

2) **Two new natural gas wells proposed in late 2004 to be installed within a half-mile of the ISFSI.**

3) **A new natural gas well proposed in early 2005 to be installed within a half-mile of the ISFSI.**

Because all four wells were further from the ISFSI than the wells evaluated for the Safety Analysis Report, their risk was considered to be bound by the prior evaluations.

(Source: ML051800479)

The May 2017 biennial report stated that no changes to the natural gas and oil infrastructure over the past two years.

(Source: ML17165A367)

Because the natural gas pipelines are explicitly addressed in both the Technical Specifications and Safety Analysis Report for the Fort St. Vrain Independent Spent Fuel Storage Installation, NRC inspectors periodically audit compliance with these regulatory requirements:

1) **NRC inspection report dated October 23, 2020**

(Source: ML20297A461)

2) **NRC inspection report dated March 23, 2017**

(Source: ML17059C642)

3) **NRC inspection report dated March 27, 2014**

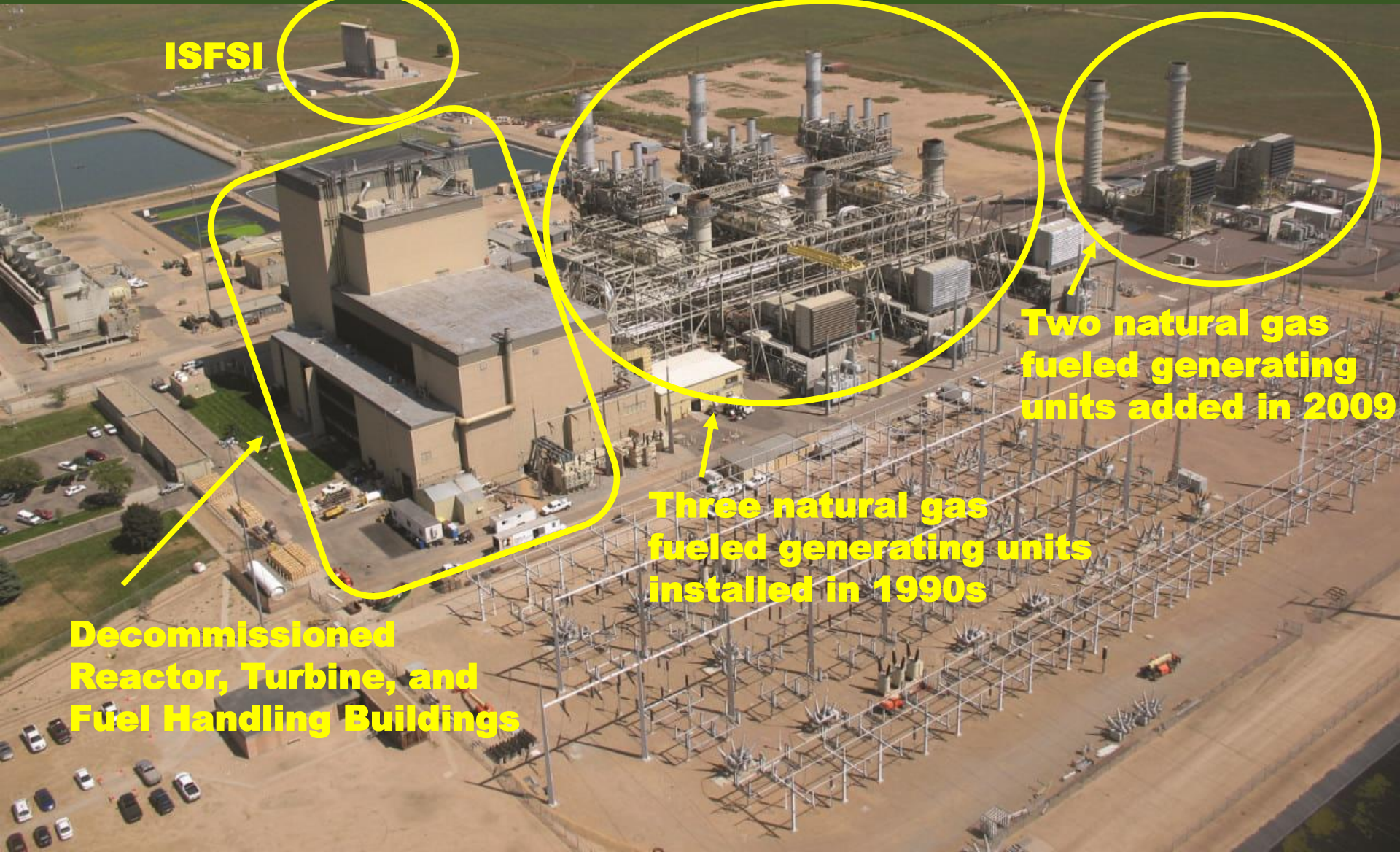
(Source; ML14087A457)

The Safety Analysis Report and Technical Specifications are essentially the "answer keys" for these NRC "tests."

Without them, the NRC's ability to test natural gas pipeline risk management is limited and its ability to grade any tests even more limited.

Fort St. Vrain Natural Gas Generating Station

Fort St. Vrain Natural Gas Generating Station



Observations on Fort St. Vrain Experience

NRC's approval of the decommissioning included explicit requirements for managing the natural gas hazard.

The Technical Specifications for the ISFSI required a natural gas monitoring program with biennial reports to the NRC.

The Safety Analysis Report for the ISFSI explicitly described postulated natural gas detonation events and their consequences.

NRC inspectors periodically evaluated -- including more than 25 years after all spent fuel was transferred into the ISFSI -- compliance at the site against the Technical Specification and Safety Analysis Report requirements.

Questions About Fort St. Vrain Experience

NRC approved the decommissioning plan more than two years before it received the independent evaluation of the natural gas pipeline hazard. Would it be prudent to understand the hazard BEFORE approving its risk management?

The natural gas hazard management allows new gas wells and pipelines as long as formal analysis of the new items is bound by formal analysis of existing wells and pipelines. From experience, I can survive a bee sting. But if I hugged a beehive, could I survive dozens of bee strings. Would it be prudent for proper risk management to account for both the number of potential threats and their individual magnitudes?

If explicit inclusion of natural gas hazard management was appropriate in the FSV approved decommissioning plan, the ISFSI Safety Analysis Report, and the ISFSI Technical Specifications, would it be equally appropriate for inclusion in comparable Indian Point documents?